



Appendix A

References

APPENDIX A. REFERENCES

The following is a list of the references cited in this Supplement. A DOE tracking and retrieving document identification number follows each reference citation. The purpose of these numbers is to assist the reader in locating a specific reference. Some reference citations have more than one tracking number, designating multiple volumes or a series of documents that relate to that particular reference.

Note: In an effort to ensure consistency among Yucca Mountain Project documents, DOE has altered the format of the references and some of the citations in the text in this Supplement from that in the Draft EIS. The following list contains notes when applicable for references cited differently in the Draft EIS.

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Appendix B

Glossary

APPENDIX B. GLOSSARY

Note: A number of the terms in the Glossary emphasize their project-specific relationship to the Yucca Mountain Repository EIS. Words in *italics* refer to other words in this glossary.

10,000-year peak of the mean annual dose

For this Supplement, the largest annual *dose* analyzed within the first 10,000 years. See *peak of the mean annual dose (post-10,000 years)*.

accident

An unplanned sequence of events that results in undesirable consequences. Examples in this EIS include an inadvertent release of *radioactive* or hazardous materials from their containers or confinement to the *environment*; vehicular accidents during the transportation of highly radioactive materials; and industrial accidents that could affect workers in the facilities.

acre-foot

The volume of water required to cover 1 acre to a depth of 1 foot (about 1,200 cubic meters or 330,000 gallons).

affected environment

For an EIS, a description of the existing *environment* (that is, site description) covering information that relates directly to the scope of the *Proposed Action*, the No-Action Alternative, and the implementing alternatives being analyzed; in other words, the information necessary to assess or understand the *impacts*. This description must contain enough detail to support the impact analysis. The information must highlight “environmentally sensitive resources,” if present; these include floodplains and wetlands, threatened and endangered species, prime and unique agricultural lands, and property of historic, archaeological, or architectural significance.

aging

Retaining *commercial spent nuclear fuel* on the surface at the proposed repository for future loading in a *disposal container*.

alkalinity

Acid-neutralizing capacity of a substance. High alkalinity conditions can promote metal corrosion.

Alloy-22

A high-nickel alloy used for the outer barrier of the waste package, and for the emplacement pallet.

areal mass loading

Used in thermal loading calculations, the amount of *heavy metal* (usually expressed in metric tons of uranium or equivalent) emplaced per unit area in the proposed repository.

backfill

The general fill that is placed in the excavated areas of an underground facility. If used, the backfill for the proposed repository could be *tuff* or other material.

barrier

Any material, structure, or condition that prevents or substantially delays the movement of water or radionuclides. See *natural barrier*.

blending

See *fuel blending*.

boiling-water reactor

(1) A nuclear power reactor that produces steam in the primary system. (2) A *nuclear reactor* that uses boiling water to produce steam to drive a turbine.

borehole

A hole drilled for purposes of collecting site characterization data or for supplying water.

cladding

The metallic outer sheath of a fuel element generally made of a zirconium alloy. It is intended to isolate the fuel element from the external *environment*.

closure

See *repository phases*.

commercial spent nuclear fuel

Commercial nuclear fuel rods that have been removed from *reactor* use. See *spent nuclear fuel* and *DOE spent nuclear fuel*.

construction

See *repository phases*.

defense-in-depth

(1) A design strategy based on a system of multiple, independent, and redundant barriers, designed to ensure that failure in any one barrier does not result in failure of the entire system. (2) The term used to describe a system of multiple barriers that mitigate uncertainties in conditions, processes, and events.

design alternative

A fundamentally different conceptual design for a repository, which could stand alone as the *License Application* repository design concept.

design feature

A specific element or attribute of the repository for which postclosure (long-term) performance could be evaluated independently of a specific repository *design alternative* or other design features.

disposal container

The vessel consisting of the *barrier* materials and internal components in which the canistered or uncanistered waste form would be placed. The disposal container would include the container barriers or shells, spacing structures or baskets, shielding integral to the container, packing contained within the container, and other absorbent materials designed to be placed internal to the container or immediately surrounding the disposal container (i.e., attached to the outer surface of the container). The filled, sealed, and tested disposal container is referred to as the *waste package*, which would be emplaced in the repository.

DOE spent nuclear fuel

Radioactive waste created by defense activities that consists of more than 250 waste forms. The major contributor to this waste form is the N-reactor fuel currently stored at the Hanford Site. This waste form also includes *naval spent nuclear fuel*.

dose

The amount of radioactive energy taken into (absorbed by) living tissues.

drift

From mining terminology, a horizontal underground passage. Includes excavations for *emplacement* (emplacement drifts) and access (main drifts).

drip shield

A corrosion-resistant engineered *barrier* that would be placed above the *waste package* to prevent seepage water from directly contacting the waste packages for thousands of years. The drip shield would also offer protection to the waste package from rockfall.

dual-purpose canister

A canister suitable for storing (in a storage facility) and shipping (in a shipping cask) *spent nuclear fuel* assemblies. At the repository, dual-purpose canisters would be removed from the shipping cask and opened. The spent nuclear fuel assemblies would be removed from the canister and placed in a disposal container. The opened canister would be recycled or disposed of offsite as low-level *radioactive* waste.

emplacement

The placement and positioning of *waste packages* in the repository emplacement *drifts*.

emplacement horizon

See *repository horizon*.

engineered barrier system

The designed, or engineered, components of the underground facility, including the *waste packages* and other engineered *barriers*.

enhanced design alternative

A combination (or variation) of one or more *design alternatives* and *design features*.

environment

(1) Includes water; air; land; and all plants, humans, and other animals living therein, and the interrelationships existing among them. (2) The sum of all external conditions affecting the life, development, and survival of an organism.

environmental impact statement (EIS)

A detailed written statement to support a decision to proceed with a major Federal action affecting the quality of the human *environment*. This is required by the *National Environmental Policy Act, as amended*. Preparation of an EIS requires a public process that includes public meetings, reviews, and comments, as well as agency responses to the public comments.

environmental resource areas

Areas examined for potential environmental impacts as part of the *National Environmental Policy Act* analysis process. Examples include air quality, hydrology, and biological resources.

fault

(1) A fracture in rock along which movement of one side relative to the other has occurred. (2) A fracture or a fracture zone in crustal rocks along which there has been movement of the fracture's two sides relative to one another, so that what were once parts of one continuous rock stratum or vein are now separated.

fuel assembly

A number of fuel rods held together by plates and separated by spacers, used in a *nuclear reactor*. Sometimes called a fuel bundle.

fuel blending

The process of loading low-heat-output waste with high-heat-output waste in a *waste package* to balance its total heat output. This process would apply only to *commercial spent nuclear fuel*.

fugitive dust

Particulate matter composed of soil that can include emissions from haul roads, wind erosion of exposed soil surfaces, and other activities in which soil is removed or redistributed.

geologic

Of or related to a natural process acting as a dynamic physical force on the Earth (faulting, erosion, mountain building resulting in rock formations, etc.).

geologic repository

A system for disposing of *radioactive* waste in excavated *geologic* media, including surface and *subsurface* areas of operation, and the adjacent part of the geologic setting that provides isolation of the radioactive waste in the controlled area.

ground support

The system (rock bolt with wire mesh, steel cast, etc.) that would be used to line the main and *emplacement drifts* to minimize rock or soils falling into the drifts.

groundwater

Water contained in pores or fractures in either the *unsaturated zone* or *saturated zone* below ground level.

hazardous waste

Waste designated as hazardous by Environmental Protection Agency or State of Nevada regulations. Hazardous waste, defined under the Resource Conservation and Recovery Act, as amended (42 USC 6901 *et seq.*), is waste that poses a potential hazard to human health or the environment when improperly treated, stored, or disposed of. Hazardous wastes appear on special Environmental Protection Agency lists or possess at least one of the following characteristics: ignitability, corrosivity, toxicity, or reactivity. Hazardous waste streams from the repository could include certain used rags and wipes contaminated with solvents. (Note: The proposed Yucca Mountain Repository would not accept hazardous waste, either solid or liquid.)

heavy metal

All uranium, plutonium, and thorium used in a manmade *nuclear reactor*.

higher-temperature repository operating mode

The S&ER flexible design would maintain the repository host rock temperatures below the boiling point of water [96°C (205°F) at the elevation of the repository] during the preclosure period with continuous ventilation of the *emplacement drifts*. After mechanical ventilation was discontinued at closure, host rock temperatures would increase above the boiling point of water, and moisture around the emplacement drifts would evaporate and be driven away from the drifts as water vapor. A boiling zone would develop around each emplacement drift, but it would not extend all the way across the *pillars*. This higher-temperature repository operating mode would

allow percolation of moisture downward past the *emplacement horizon* through central portions of the rock pillars between the drifts. See *lower-temperature repository operating mode*.

high-level radioactive waste

(1) The highly *radioactive* material that resulted from the reprocessing of *spent nuclear fuel*, including liquid waste produced directly in reprocessing, and any solid material derived from such liquid waste that contains fission products in sufficient concentrations. (Note: DOE would vitrify liquid high-level radioactive waste before shipping it to the repository.) (2) Other highly radioactive material that the Nuclear Regulatory Commission, consistent with existing law, determines by rule requires permanent isolation.

impact

For an EIS, the positive or negative effect of an action (past, present, or future) on the natural *environment* (land use, air quality, water resources, geological resources, ecological resources, aesthetic and scenic resources) and the human environment (infrastructure, economics, social, and cultural).

impact limiters

Devices attached to the *waste package* transporter that would help absorb impact energy in the event of a collision. The railcars and trucks that would transport spent nuclear fuel and high-level radioactive waste to the repository site would also have impact limiters.

infiltration

The process of water entering the soil at the ground surface and the ensuing movement downward. Infiltration becomes percolation when water has moved below the depth at which it can be removed (to return to the atmosphere) by evaporation or evapotranspiration.

invert

The structure constructed in a *drift* to provide the floor of that drift. In an *emplacement* drift, ballast in the invert would serve as a *barrier* to migration of radionuclides that escaped from breached *waste packages*.

License Application

An application to the Nuclear Regulatory Commission to construct a *geologic repository* for the disposal of *spent nuclear fuel* and *high-level radioactive waste*. The application would be considered by the Nuclear Regulatory Commission in any decision whether to grant DOE authorization to begin constructing a repository.

line-loading repository design

A waste *emplacement* design in which *waste packages* would be spaced very closely along the *drift*.

linear thermal load

Heat output per unit length of the emplacement drift; expressed in kilowatts per meter.

lower-temperature repository operating mode

The S&ER flexible design would have the ability to hold repository host rock temperatures below the boiling point of water [96°C (205°F) at the elevation of the repository] after closure by a combination of methods such as increasing the continuous ventilation period, aging the fuel prior to *emplacement*, and increasing the spacing between emplaced waste packages. The lower-temperature repository operating mode ranges include conditions under which the drift rock wall

temperatures would be below the boiling point of water, and conditions under which the waste package surface temperature would not exceed 85°C (185°F). To bound the impact analysis, DOE considered conditions under which the rock wall temperatures would be above the boiling point of water, and conditions under which waste package surface temperatures would not exceed 85°C. See *higher-temperature repository operating mode*.

maintenance

Activities during the repository operation and monitoring phase including maintenance of *subsurface* monitoring and instrumentation systems and utilities (compressed air, water supply, fire water, wastewater system, power supply, and lights), maintenance of the main ventilation fan installations and surface facilities related to underground activities, and site security. Maintenance also preserves the capability to retrieve emplaced *waste packages*. See *repository phases*.

maximally exposed individual

A hypothetical individual whose location and habits result in the highest total radiological or chemical exposure (and thus *dose*) from a particular source for all exposure routes (for example, inhalation, ingestion, direct exposure). The EIS analyses used the concept of the maximally exposed individual to evaluate potential short-term impacts to individuals around the repository and from transportation (and for some aspects of the No-Action Alternative). For potential impacts to individuals from long-term repository performance, see *receptor*.

maximum reasonably foreseeable accident

An accident characterized by extremes of mechanical (impact) forces, heat (fire), and other conditions that would lead to the highest foreseeable consequences. In general, accidents with conditions that have a chance of occurring more often than 1 in 10 million in a year are considered to be reasonably foreseeable.

metric tons of heavy metal (MTHM)

Quantities of *spent nuclear fuel* without the inclusion of other materials such as *cladding* (the tubes containing the fuel) and structural materials. A metric ton is 1,000 kilograms (1.1 tons or 2,200 pounds). Uranium and other metals in *spent nuclear fuel* (such as thorium and plutonium) are called *heavy metals* because they are extremely dense; that is, they have high weights per unit volume.

monitoring

Activities during the repository operation and monitoring phase including the surveillance and testing of *waste packages* and the repository for *performance confirmation*. See *repository phases*.

National Environmental Policy Act, as amended (NEPA; 42 USC 4321 *et seq.*)

The Federal statute that is the national charter for protection of the *environment*. The Act is implemented by procedures issued by the Council on Environmental Quality and DOE.

natural barrier

The physical components of the geologic *environment* that individually and collectively act to limit the movement of water or radionuclides. See *barrier*.

natural ventilation

Ventilation that results from a naturally occurring pressure differential common in underground mines, caused by a difference in density between the air columns in the intake and exhaust shafts

or ramps. The density difference is generally caused by a difference in air temperature between the two openings. In relation to this EIS, the repository would be unique in that, due to the heat output of the emplaced waste, the exhaust air temperature would virtually always be higher than the intake temperature. The heat supplied by the waste and the difference in elevation between the intake and exhaust shaft portals would mean that there would always be a pressure differential, and that it would always be positive (that is, it would induce flow from the intakes to the exhausts).

naval spent nuclear fuel

Spent nuclear fuel discharged from reactors in surface ships, submarines, and training reactors operated by the U.S. Navy.

neutron absorber

A material (such as boron or gadolinium) that absorbs neutrons. Used in *nuclear reactors*, transportation casks, and *waste packages* to control neutron activity.

nuclear reactor

A device in which a nuclear fission chain reaction can be initiated, sustained, and controlled to generate heat or to produce useful radiation.

Nuclear Waste Policy Act, as amended (NWPA; 42 USC 10101 *et seq.*)

The Federal statute enacted in 1982 (Public Law 97-425, 96 Stat. 2201) that established the DOE Office of Civilian Radioactive Waste Management and defined its mission to develop a Federal system for the management and geologic disposal of *commercial spent nuclear fuel* and other *high-level radioactive wastes*, as appropriate. The NWPA specifies other Federal responsibilities for nuclear waste management, established the Nuclear Waste Fund to cover the cost of geologic disposal, authorized interim storage under certain circumstances, and defined interactions between Federal agencies and the states, local governments, and Native American tribes. The Nuclear Waste Policy Act of 1982 was substantially amended in 1987 [Nuclear Waste Policy Amendments Act of 1987 (Public Law 100-203, 101 Stat. 1330)] and 1992 [Energy Policy Act of 1992 (Public Law 102-486, 106 Stat. 2776)].

operation and monitoring

See *repository phases*.

peak of the mean annual dose (post-10,000 years)

For this Supplement, the maximum of the mean annual *dose* analyzed for the 1-million-year postclosure period. Because the dose would decline after this peak, this would be the peak for all time after closure. See *10,000-year peak of the mean annual dose*.

perennial yield

The amount of usable water from a *groundwater* aquifer that can be economically withdrawn and consumed each year for an indefinite period. It cannot exceed the natural recharge to that aquifer and ultimately is limited to the maximum amount of discharge that can be used for beneficial use.

performance confirmation

The program of tests, experiments, and analyses conducted to evaluate the accuracy and adequacy of the information used to determine with reasonable assurance that the performance objectives for the period after *permanent closure* will be met.

permanent closure

Final sealing of *shafts* and *boreholes* of the underground facility.

photovoltaic

Capable of generating a voltage as a result of exposure to radiation. Solar power generation systems use photovoltaic energy from the sun's radiation to produce electricity.

pillar

The rock wall between adjacent *emplacement drifts*.

PM₁₀

All particulate matter in the air with an aerodynamic diameter less than or equal to a nominal 10 micrometers (0.0004 inch). Particles less than this diameter are small enough to be breathable and could be deposited in lungs.

portal

Surface entrance to a mine, particularly in a *drift* or tunnel. The North and South Portals are the two primary entrances to the *subsurface* facilities of the proposed Yucca Mountain Repository.

pressurized-water reactor

A nuclear power *reactor* that uses water under pressure as a coolant. The water boiled to generate steam is in a separate system.

primary impact indicators

The most important contributions or parameters used to determine the impacts to a particular *environmental resource area*.

proposed action

The activity proposed to meet the purpose and need for agency action. An EIS analyzes the environmental *impacts* of a proposed action. A proposed action includes the project and its related support activities (preconstruction, construction, and operation, along with postoperational requirements). The Proposed Action in this EIS is the construction, operation and monitoring, and eventual closure of a *geologic repository* for *spent nuclear fuel* and *high-level radioactive waste* at Yucca Mountain in Nevada (see *repository phases*).

radioactive

Emitting radioactivity.

reactor

See *nuclear reactor*.

receptor

A hypothetical person who is exposed to environmental contaminants (in this case radionuclides) in such a way—by a combination of factors including location, lifestyle, dietary habits, etc.—that this individual is representative of the exposure of the general population. DOE used this hypothetical individual to evaluate long-term repository performance. The receptor represents the “Reasonably Maximally Exposed Individual (RMEI)” defined in proposed 40 CFR Part 197 (64 *FR* 46976, August 27, 1999) or the “Average Member of the Critical Group” in proposed 10 CFR Part 63 (64 *FR* 8640, February 22, 1999). The Draft EIS defined the receptor slightly differently and called this hypothetical person the *maximally exposed individual*, which is still used for evaluating short-term impacts.

repository block

The portion of rock in Yucca Mountain that would house the repository, if the site is found suitable.

repository horizon

The area within the *repository block* where *emplacement drifts* would be excavated. Also called emplacement horizon.

repository phases

The development of a monitored geologic repository at Yucca Mountain, if approved, would have three phases, as follows:

- *Construction:* Activities during this phase would include preparing the site, constructing surface waste handling and support facilities, excavating and equipping a portion of the repository *subsurface* for initial waste *emplacement*, and conducting initial verification testing of components and systems.
- *Operation and monitoring:* Repository operations activities would include waste receipt, repackaging, and *emplacement* in the repository; continuing subsurface development for waste emplacement; *monitoring*; and *maintenance*. Monitoring would begin with the initial emplacement of waste in the repository and would end at repository *closure*. In addition, the maintenance of repository facilities would continue until the closure of the repository. See *monitoring, maintenance*.
- *Closure:* The closure of the *subsurface* repository facilities would include the removal and salvage of equipment and materials; filling of the main *drifts*, access ramps, and ventilation *shafts*; and sealing of openings, including ventilation shafts, access ramps, and *boreholes*. Surface closure activities would include the construction of monuments to mark the repository location, decommissioning and demolition of facilities, and restoration of the site to its approximate condition before the construction of the repository facilities.

S&ER flexible design

As used in this Supplement, the repository design and operating modes presented in the *Yucca Mountain Science and Engineering Report: Technical Information Supporting Site Recommendation Consideration*. See *higher-temperature repository operating mode* and *lower-temperature repository operating mode*.

saturated zone

The region below the *water table* where rock pores and fractures are completely saturated with water.

shaft

For the Yucca Mountain Repository, an excavation or vertical passage of limited area, compared to its depth, used to ventilate underground facilities.

shielding

Any material that provides radiation protection.

Site Recommendation

A recommendation by the Secretary of Energy to the President that the Yucca Mountain site be approved for development as the Nation's first *spent nuclear fuel* and *high-level radioactive*

waste repository. If the site is determined to be suitable, this recommendation is expected in Fiscal Year 2001.

spent nuclear fuel

Fuel that has been withdrawn from a *nuclear reactor* following irradiation, the component elements of which have not been separated by reprocessing. For this project, this refers to (1) intact, nondefective *fuel assemblies*, (2) failed fuel assemblies in canisters, (3) fuel assemblies in canisters, (4) consolidated fuel rods in canisters, (5) nonfuel-assembly hardware inserted in *pressurized-water reactor* fuel assemblies, (6) fuel channels attached to *boiling-water reactor* fuel assemblies, and (7) nonfuel-assembly hardware and structural parts of assemblies resulting from consolidation in canisters.

subsurface

A zone below the surface of the Earth, the *geologic* features of which are principally layers of rock that have been tilted or *faulted* and are interpreted on the basis of drill hole records and geophysical (seismic or rock vibration) evidence. In general, it is all rock and solid materials lying beneath the Earth's surface.

thermal loading

(1) The spatial density at which *waste packages* would be emplaced within the repository as characterized by the areal power density and the *areal mass loading*. (2) The application of heat to a system, usually measured in terms of watts per unit area. The thermal load for a repository would be the watts per acre produced by the *radioactive waste* in the active disposal area.

thermal shunt

Usually aluminum metal structure that would be added to *waste packages* as needed to greatly improve heat conduction between the center of the waste package and the outer edge, thereby providing a reliable means to keep temperature of the *cladding* within design limits.

Total System Performance Assessment

A risk assessment that quantitatively estimates how the proposed Yucca Mountain Repository system would perform under the influence of specific features, events, and processes, incorporating *uncertainty* in the models and data.

trunnion

A cylindrical projection used for lifting.

tuff

Igneous rock formed from compacted volcanic fragments from pyroclastic (explosively ejected) flows with particles generally smaller than 4 millimeters (about 0.16 inch) in diameter—the most abundant type of rock at the Yucca Mountain site. Nonwelded tuff results when volcanic ash cools in the air sufficiently that it doesn't melt together, yet later becomes rock through compression. See *welded tuff*.

uncanistered spent nuclear fuel

Fuel placed directly into storage containers or shipping casks without first being placed in a canister.

uncertainty

A measure of how much a calculated or estimated value that is used as a reasonable guess or prediction might vary from the unknown true value.

unsaturated zone

The zone of soil or rock below the ground surface and above the *water table*.

Viability Assessment

An assessment of the prospects for geologic disposal at the Yucca Mountain site, based on repository and *waste package* design, a *Total System Performance Assessment*, a *License Application* plan, and repository cost and schedule estimates. DOE issued the *Viability Assessment of a Repository at Yucca Mountain* in December 1998.

waste form

A generic term that refers to the different types of *radioactive* wastes.

waste package

A sealed container containing waste that is ready for emplacement. The waste package would contain the *waste form* and any containers, spacing structure or baskets, and other absorbent materials immediately surrounding an individual waste container placed internally to the container or attached to the outer surface of the *disposal container*.

water table

- (1) The upper limit of the *saturated zone* (the portion of the ground wholly saturated with water).
- (2) The upper surface of a zone of saturation above which the majority of pore spaces and fractures are less than 100 percent saturated with water most of the time (*unsaturated zone*) and below which the opposite is true (saturated zone).

welded tuff

A *tuff* deposited under conditions where the particles making up the rock were heated sufficiently to cohere. In contrast to nonwelded tuff, welded tuff is denser, less porous, and more likely to be fractured.



Appendix C

Preparers and Contributors

APPENDIX C. PREPARERS, CONTRIBUTORS, AND REVIEWERS

C.1 Preparers and Contributors

This appendix lists the individuals who filled primary roles in the preparation of this *Supplement to the Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*. As Document Manager, Kenneth J. Skipper of the U.S. Department of Energy (DOE) Yucca Mountain Site Characterization Office directed the preparation of the Supplement until March 2001; Jane R. Summerson of DOE is the current Document Manager. Wendy R. Dixon, Robin L. Sweeney, and Joseph D. Ziegler of DOE served as advisors to Supplement preparation. Primary support and assistance to DOE was provided by the Supplement Preparation Team, led by Joseph W. Rivers, Jr., of Jason Technologies Corporation; other members of the team included Tetra Tech NUS Inc., Dade Moeller & Associates, and Batelle Memorial Institute.

Judith A. Shipman coordinated the work of the Jason Technologies Corporation production team (Elisa Aguilar, Dalene Glanz, Laura Hall, Virginia Hutchins, and Robin Klein). Glenn Caprio, Marcy Gershin, Cynthia Langdale, Angelica Marquez, Barbara Rhoads, and Dawn Siekerman provided scheduling and recordkeeping support.

DOE provided direction to the Supplement Preparation Team, which was responsible for developing the analytical methodology and alternatives, coordinating the work tasks, performing the impact analyses, and producing the document. DOE was responsible for data quality, the scope and content of the Supplement, and issue resolution and direction.

In addition, the Management and Operating Contractor to the Civilian Radioactive Waste Management System (TRW Environmental Safety Systems Inc., Bechtel-SAIC Corporation, and their subcontractors) under the direction of the DOE Yucca Mountain Site Characterization Office assisted in the preparation of supporting documentation and information for the Supplement. These organizations worked closely with the Supplement Preparation Team under DOE direction.

DOE independently evaluated all supporting information and documentation prepared by these organizations. Further, DOE retained the responsibility for determining the appropriateness and adequacy of incorporating any data, analyses, and results of other work performed by these organizations in the Supplement. The Supplement Preparation Team was responsible for integrating such work into the document.

As required by Federal regulations (40 CFR 1506.5c), Jason Technologies Corporation and its subcontractors have signed National Environmental Policy Act (NEPA) Disclosure Statements in relation to the work they performed on this Supplement. These statements appear at the end of this appendix.

Name	Education	Experience	Responsibility
U.S. Department of Energy			
Kenneth J. Skipper	B.S., Geology, 1984	19 years – geotechnical/ environmental project management; Federal civil works projects; planning, construction, operations, and performance monitoring	Document Manager until March 2001

Name	Education	Experience	Responsibility
Jane R. Summerson	Ph.D., Geology, 1991 M.S., Geobiology, 1985 M.A., Anthropology, 1978 B.A., Anthropology, 1977	11 years – waste management projects with the DOE Office of Civilian Radioactive Waste Management	Document Manager
Wendy R. Dixon	Postgraduate studies, Geology and Environmental Science M.B.A., Business B.A., Sociology	21 years – management of nuclear-related projects; 14 years – regulatory compliance and field management; 6 years – safety and health	Senior Advisor for Environmental Policy
Robin L. Sweeney	Ph.D. student, Environmental Science and Public Policy M.S., Geosciences, 1987 B.S., Biological Sciences, 1980	22 years – hazardous and nuclear waste field; waste management, RCRA/CERCLA ^a facility assessments, sampling and monitoring, project/program management, laboratory research	Senior Technical Specialist; NEPA Compliance Officer
Joseph D. Ziegler	B.S., Engineering (Nuclear), 1975	25 years – nuclear engineering, nuclear safety, environmental assessment, and project management; Federal and commercial nuclear projects	Senior Technical Advisor

Supplement Preparation Team

Joseph W. Rivers, Jr. Jason Technologies Corporation	B.S., Mechanical Engineering, 1982	17 years – commercial and DOE nuclear projects; design, systems engineering, safety analysis, and regulatory compliance	Project Manager
David R. Wayman Jason Technologies Corporation	M.B.A., Business Administration, 1988 B.S., Construction Technology, 1980	19 years – commercial and DOE projects; construction engineering, nuclear safety analysis, environment compliance and permitting	Deputy Project Manager
Diane E. Morton Jason Technologies Corporation	B.S., Chemical Engineering, 1979	20 years – DOE nuclear and environmental projects; project/program management, assessments, planning	Document Manager

Name	Education	Experience	Responsibility
John O. Shipman Jason Technologies Corporation	B.A., English Literature, 1966	33 years – NEPA documentation, technical writing and editing, publications management; 10 years – public participation	Document Production Manager, Editor
David Crowl Jason Technologies Corporation	B.A., Computer Science, 1985	16 years – editing and document production	Editor
Keith D. Davis, PE Jason Technologies Corporation	M.S., Civil and Environmental Engineering, 1976 B.S., Civil Engineering, 1973	25 years – civil and environmental engineering; waste management; facility permitting and closure; site investigations, feasibility studies, and remedial action planning; 6 years – NEPA documentation	Hydrology; soils
Peter R. Davis Jason Technologies Corporation	Oak Ridge School of Reactor Technology, 1962 B.S. Physics, 1961	37 years – nuclear reactor and nuclear facility safety analysis and risk assessment	Accidents
Sara A. Doersam Jason Technologies Corporation	B.A., Psychology, 1982	2 years – technical editing; 6 years – newspaper publishing and editing; 14 years – health administration	Editor
Mary N. Hoganson Tetra Tech NUS Inc.	M.S., Biology, 1989 B.S., Biology, 1984	14 years – waste management and waste minimization; 6 years – NEPA document preparation	Waste management and hazardous materials
Richard H. Holder Jason Technologies Corporation	M.B.A., Business Administration, 1986 M.S., Electrical Engineering, 1970 B.S., Electrical Engineering, 1966	33 years – team and line management for nuclear utility, industrial, and overseas projects	Proposed Action and alternatives
R. Kingsley House, PE Jason Technologies Corporation	M.S., Engineering Science/Nuclear Option, 1963 B.S., Mechanical Engineering, 1960 Nevada Registration No. 13062, 1997	40 years – nuclear and non-nuclear facility design, construction, testing, and operation; hazards analysis, safety analysis, and environmental impact analysis	Utilities, energy, materials, and site services; offsite manufacturing of disposal containers, shipping casks, drip shields, waste package supports, and related components

Name	Education	Experience	Responsibility
Tracy A. Ikenberry, CHP Dade Moeller & Associates	M.S., Radiology & Radiation Biology, 1982 B.A., Biology, 1979	17 years – environmental and occupational radiation protection; 6 years – NEPA document management and technical analysis	Air quality; health and safety
David H. Lester Jason Technologies Corporation	Ph.D., Chemical Engineering, 1969 M.S., Chemical Engineering, 1966 B.Chem., Chemical Engineering, 1964	27 years – hazardous and nuclear waste management; nuclear Safety Analysis Reports, hazards analysis of waste storage operations, risk assessment of low-level nuclear waste burial operations, groundwater contamination transport modeling, performance assessment of high-level nuclear waste systems, design of treatment systems, design and analysis of high-level waste packages, and soil remediation studies	Long-term performance
Donna L. Osborne Jason Technologies Corporation	20 years experience	20 years – technical editing, document production and coordination; 1 year – NEPA documentation	Editor
Judith A. Shipman Jason Technologies Corporation	A.A., General Studies, 1991	25 years – NEPA documentation, document production coordination, editing	Editor
Ruth Weiner Jason Technologies Corporation	Ph.D., Chemistry, 1962 M.S., Physics, 1957 B.S., Physics, 1956	14 years – risk assessment of airborne pollutants and transportation risks; 25 years – environmental impact assessment; 26 years – professor of chemistry and environmental studies; radioactive waste disposal	Transportation risk
Dee H. Walker Jason Technologies Corporation	Ph.D., Chemical Engineering, 1963 M.S., Chemical Engineering, 1962 Oak Ridge School of Reactor Technology, 1954 B.S., Chemical Engineering, 1953	46 years – nuclear engineering; 11 years – effects of radiological releases on humans and the environment	Health and safety

- a. RCRA/CERCLA = Resource Conservation and Recovery Act/Comprehensive Environmental Response, Compensation, and Liability Act.

C.2 Reviewers

The DOE Yucca Mountain Site Characterization Office incorporated input to the preparation of this Supplement from a number of other DOE offices that reviewed the document while it was under development. These included the Offices of Environmental Management, Naval Reactors, Nuclear Energy, Materials Disposition, the National Spent Fuel Program, and the National High-Level Waste Program. The DOE Yucca Mountain Site Characterization Office and Nevada Operations Office also participated in the reviews of this Supplement. In addition, personnel from the DOE Office of Civilian Radioactive Waste Management Technical Support Services Contractor (Booz-Allen & Hamilton and its subcontractors) provided technical review and other support.

QUALIFICATION CRITERION NO. 1

NEPA DISCLOSURE STATEMENT FOR
PREPARATION OF THE
ENVIRONMENTAL IMPACT STATEMENT FOR A GEOLOGIC REPOSITORY FOR THE DISPOSAL OF
SPENT NUCLEAR FUEL AND HIGH-LEVEL RADIOACTIVE WASTE AT YUCCA MOUNTAIN, NYE
COUNTY, NEVADA

CEQ Regulations at 40 CFR 1506.5(c), which have been adopted by the DOE (10 CFR 1021), require contractors who will prepare and EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial interest or other interest in the outcome of the project" for purpose of this disclosure is defined in the March 23, 1981, guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations", 46 FR 18026-18038 at Question 17a and b.

"Financial or other interest in the outcome of the project" includes "any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firm's other clients)". See 46 FR 18026-18031.

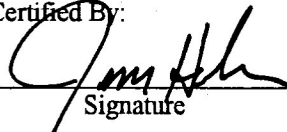
In accordance with these requirements, the offeror and the proposed subcontractors hereby certify as follows. (check either (a) or (b) and list financial or other interest if (b) is checked)

- (a) ☒ Contractor has no financial or other interest in the outcome of the project.
- (b) ☐ Offeror and any proposed subcontractor have the following financial or other interest in the outcome of the project and hereby agree to divest themselves of such interest prior to award of this contract.

Financial or Other Interest

- 1.
- 2.
- 3.

Certified By:


Signature

James S. Holm

Name (Printed)

Director of Contracts

Title

Jason Associates Corporation

Company

June 7, 1999

Date

QUALIFICATION CRITERION NO. 1

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ENVIRONMENTAL IMPACT STATEMENT FOR A GEOLOGIC REPOSITORY FOR THE DISPOSAL OF
SPENT NUCLEAR FUEL AND HIGH-LEVEL RADIOACTIVE WASTE AT YUCCA MOUNTAIN, NYE
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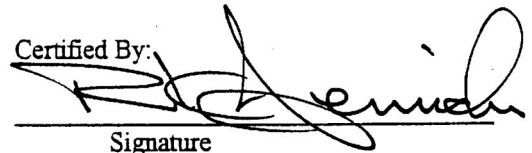
In accordance with these requirements, the offeror and the proposed subcontractors hereby certify as follows.
(check either (a) or (b) and list financial or other interest if (b) is checked)

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Financial or Other Interest

- 1.
- 2.
- 3.

Certified By:


Signature

RALPH K. HENRICKS
Name (Printed)
CONTRACTING OFFICER

BATTELLE MEMORIAL INSTITUTE
COLUMBUS OPERATIONS

Company

June 7, 1999
Date

QUALIFICATION CRITERION NO. 1

**NEPA DISCLOSURE STATEMENT FOR
PREPARATION OF THE
ENVIRONMENTAL IMPACT STATEMENT FOR A GEOLOGIC REPOSITORY FOR THE DISPOSAL
OF SPENT NUCLEAR FUEL AND HIGH-LEVEL RADIOACTIVE WASTE AT
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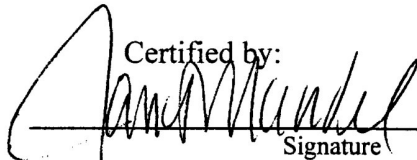
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In accordance with these requirements, the offeror and the proposed subcontractors hereby certify as follows: (check either (a) or (b) and list financial or other interest if (b) is checked).

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Financial or Other Interest

- 1.
- 2.
- 3.

Certified by: 
Signature

Janet M. Mandel

Name (Printed)

Manager, Contract Operations

Title

Tetra Tech NUS, Inc.

Company

June 4, 1999

Date

QUALIFICATION CRITERION NO. 1

NEPA DISCLOSURE STATEMENT FOR
PREPARATION OF THE
ENVIRONMENTAL IMPACT STATEMENT FOR A GEOLOGIC REPOSITORY FOR THE DISPOSAL OF
SPENT NUCLEAR FUEL AND HIGH-LEVEL RADIOACTIVE WASTE AT YUCCA MOUNTAIN, NYE
COUNTY, NEVADA

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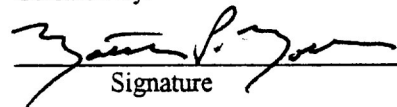
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Financial or Other Interest

- 1.
- 2.
- 3.

Certified By:


Signature

Matthew P. Moeller
Name (Printed)

Vice President
Title

Dade Moeller & Assoc.
Company

June 4, 1999
Date



Appendix D

Distribution List

APPENDIX D. DISTRIBUTION LIST

The U.S. Department of Energy (DOE) is providing copies of this Supplement to Federal, state, and local elected and appointed officials and agencies of government; Native American groups; national, state, and local environmental and public interest groups; and other organizations and individuals listed below. In addition, DOE is sending copies of the Supplement to all persons who commented on the *Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*. DOE will provide copies to other interested organizations or individuals on request.

D.1 United States Congress

D.1.1 UNITED STATES SENATORS FROM NEVADA

The Honorable Harry Reid
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The Honorable John Ensign
United States Senate

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The Honorable Robert Smith
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The Honorable Harry Reid
Ranking Member
Committee on Environment and Public Works

D.1.3 UNITED STATES REPRESENTATIVES FROM NEVADA

The Honorable Jim Gibbons
United States House of Representatives

The Honorable Shelley Berkley
United States House of Representatives

D.1.4 UNITED STATES HOUSE OF REPRESENTATIVES COMMITTEES

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The Honorable Bob Stump
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The Honorable John D. Dingell
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Committee on Energy and Commerce

The Honorable Rick Boucher
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Subcommittee on Energy and Air Quality
Committee on Energy and Commerce

The Honorable Nick J. Rahall II
Ranking Minority Member
Committee on Resources

The Honorable James L. Oberstar
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Committee on Transportation and Infrastructure

D.2 Federal Agencies

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Director, Division of Information Technology and
Security
Defense Nuclear Facilities Safety Board

Ms. Andree DuVarney
National Environmental Coordinator
Ecological Sciences Division
Natural Resources Conservation Service
U.S. Department of Agriculture

Dr. Frank Monteferrante
Director, Compliance Review Division
Economic Development Administration
U.S. Department of Commerce

Mr. Rick Lemaire
Deputy for Environmental Planning, Education,
and Training
Office of Environment, Safety and Occupational
Health
Department of the Air Force
U.S. Department of Defense

Mr. Timothy P. Julius
Office of the Director of Environmental Programs
Office of the Assistant Chief of Staff for
Installation Management
Department of the Army
U.S. Department of Defense

Ms. Kimberley DePaul
Head, Environmental Planning and NEPA
Compliance Program
Office of Chief of Naval Operations/N456
Department of the Navy
U.S. Department of Defense

Mr. A. Forester Einarsen
NEPA Coordinator
Office of Environmental Policy, CECW-AR-E
U.S. Army Corps of Engineers
U.S. Department of Defense

Mr. James T. Melillo
Executive Director
Environmental Management Advisory Board
U.S. Department of Energy

Mr. Willie R. Taylor
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Office of Environmental Policy and Compliance
U.S. Department of the Interior

Mr. Michael Soukup
Associate Director
Natural Resource Stewardship and Science
National Park Service
U.S. Department of the Interior

Mr. Jack Haugrud
Chief
General Litigation Section
Environment and Natural Resources Division
U.S. Department of Justice

Ms. Camille Mittleholtz
Environmental Team Leader
Office of Transportation Policy
U.S. Department of Transportation

Mr. Steve Grimm
Senior Program Analyst, RRP-24
Office of Policy and Program Development
Federal Railroad Administration
U.S. Department of Transportation

Dr. Robert A. McGuire, DHM2
Deputy Associate Administrator
Hazardous Materials Safety Research and Special
Programs Administration
U.S. Department of Transportation

Ms. Susan Absher
Office of Federal Activities
NEPA Compliance Division
U.S. Environmental Protection Agency

Mr. Kenneth Czyscinski
Office of Radiation and Indoor Air
U.S. Environmental Protection Agency

Mr. David Huber
Office of Ground Water and Drinking Water
U.S. Environmental Protection Agency

Mr. Robert Barles
Office of Ground Water and Drinking Water
U.S. Environmental Protection Agency

Mr. Dennis O'Connor
Office of Radiation and Indoor Air
U.S. Environmental Protection Agency

Ms. Christine Todd Whitman
Administrator
U.S. Environmental Protection Agency

Ms. Elizabeth Higgins
Director, Office of Environmental Review
Regional Administrator's Office
Region 1
U.S. Environmental Protection Agency

Mr. Robert Hargrove
Chief, Strategic Planning and Multimedia
Programs
Region 2
U.S. Environmental Protection Agency

Mr. John Forren
NEPA and Wetlands Coordinator
Region 3
U.S. Environmental Protection Agency

Mr. Heinz Mueller
Chief, Office of Environmental Assessment
Region 4
U.S. Environmental Protection Agency

Mr. Ken Westlake (B-19J)
NEPA Coordinator
Office of Strategic and Environmental Analysis
Region 5
U.S. Environmental Protection Agency

Mr. Michael P. Jansky
Regional Environmental Review Coordinator
Office of Planning and Coordination
Region 6
U.S. Environmental Protection Agency

Mr. Joe Cothorn
NEPA Coordination Team Leader
Region 7
U.S. Environmental Protection Agency

Ms. Cindy Cody
Chief, NEPA Unit
Region 8
U.S. Environmental Protection Agency

Mr. David Tomsovic (CMD-2)
Region 9
U.S. Environmental Protection Agency

Mr. Richard B. Parkin (ECO-088)
Unit Manager, Geographic Implementation Unit
Office of Ecosystems and Communities
Region 10
U.S. Environmental Protection Agency

Mr. Mark Robinson
Director, Division of Environmental and
Engineering Review
Federal Energy Regulatory Commission

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Director, Energy, Resources, and Science Issues
U.S. General Accounting Office

Mr. Lawrence Rudolph
General Counsel
National Science Foundation

The Honorable Richard A. Meserve
Chairman
U.S. Nuclear Regulatory Commission

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U.S. Nuclear Regulatory Commission

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U.S. Nuclear Regulatory Commission

The Honorable Edward J. McGaffigan, Jr.
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U.S. Nuclear Regulatory Commission

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U.S. Nuclear Regulatory Commission

Mr. Keith McConnell
Assistant for Materials
U.S. Nuclear Regulatory Commission

Mr. Carl Paperiello
Deputy Executive Director for Materials, Research,
and State Programs
U.S. Nuclear Regulatory Commission

Mr. David Brooks
Division of Waste Management
U.S. Nuclear Regulatory Commission

Mr. Thomas H. Essig
Chief, Environmental Performance and Assessment
Branch
Division of Waste Management
U.S. Nuclear Regulatory Commission

Ms. Cynthia A. Carpenter
Branch Chief, Generic Issues, Environmental,
Financial, and Rulemaking Branch
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission

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Mr. Daniel J. Goode
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Mr. Barney Lewis
U.S. Geological Survey

Mr. Thomas O'Toole
Cadastral Surveyor
Bureau of Land Management
Bishop Field Station

Mr. Steve Addington
Field Office Manager
Bureau of Land Management
Bishop Field Station

Mr. Brian Amme
Division of Natural Resources, Lands, and
Planning
Bureau of Land Management
Nevada State Office

Mr. Mark T. Morse
Field Office Manager
Bureau of Land Management
Las Vegas Field Office

Ms. Helen M. Hankins
Field Office Manager
Bureau of Land Management
Elko Field Office

Mr. W. Craig MacKinnon
Field Station Manager
Bureau of Land Management
Tonopah Field Station

Mr. Gene A. Kolkman
Field Office Manager
Bureau of Land Management
Ely Field Office

Mr. George Meckfessel
Planning and Environmental Coordinator
Bureau of Land Management
Needles Field Office

Mr. John "Jack" S. Mills
Environmental Coordinator
Bureau of Land Management
California State Office

Mr. Timothy M. Read
Field Manager
Bureau of Land Management
Barstow Field Office

Mr. Ahmed Mohsen
Environmental Coordinator
Bureau of Land Management
Ridgecrest Field Office

Mr. Terry A. Reed
Field Office Manager
Bureau of Land Management
Winnemucca Field Office

Mr. John O. Singlaub
Field Office Manager
Bureau of Land Management
Carson City Field Office

Mr. Gerald M. Smith
Field Office Manager
Bureau of Land Management
Battle Mountain Field Office

Vacant
Field Station Manager
Bureau of Land Management
Caliente Field Station

Mr. Richard Martin
Superintendent
National Park Service
Death Valley National Park

Ms. Kathleen A. Carlson
Manager
U.S. Department of Energy
Nevada Operations Office

Ms. Beverly A. Cook
Manager
U.S. Department of Energy
Idaho Operations Office

Mr. Richard E. Glass
Manager
U.S. Department of Energy
Albuquerque Operations Office

Ms. G. Leah Dever
Manager
U.S. Department of Energy
Oak Ridge Operations Office

Mr. Keith A. Klein
Manager
U.S. Department of Energy
Richland Operations Office

Mr. Gregory P. Rudy
Manager
U.S. Department of Energy
Savannah River Operations Office

Mr. Marvin Gunn
Manager
U.S. Department of Energy
Chicago Operations Office

Mr. John Muhlestein
Stanford Site Office Director
U.S. Department of Energy

Mr. Richard H. Nolan
Berkeley Site Office
U.S. Department of Energy

Mr. Walter Warnick
Director
Office of Scientific and Technical Information
U.S. Department of Energy

Department of Energy Advisory Boards

Mr. Doug Sarno
Contractor Technical Liaison
c/o Fernald Citizens Advisory Board
Phoenix Environmental Corporation

Ms. Ruth Siguenza
SSAB Administrator
Hanford Site Advisory Board
c/o EnviroIssues

Ms. Wendy Green Lowe
SSAB Administrator
Idaho National Engineering and Environmental
Laboratory Citizens Advisory Board
c/o Jason Associates Corporation

Ms. Ann Dubois
SSAB Administrator
Northern New Mexico Citizens Advisory Board

Ms. Kay Planamento
SSAB Administrator
Nevada Test Site Programs (NTS-CAB)
c/o PAI

Ms. Sheree Black
SSAB Administrator
Oak Ridge Reservation Environmental
Management Site-Specific Advisory Board

Ms. Deb Thompson
Office Administrator
Rocky Flats Citizens Advisory Board

Ms. Dawn Haygood
SSAB Administrator
Savannah River Site Citizens Advisory Board
c/o Westinghouse Savannah River Company
Public Involvement Office

D.3 State of Nevada

D.3.1 STATEWIDE OFFICES AND LEGISLATURE

The Honorable Kenny Guinn
Governor of Nevada

The Honorable Lorraine Hunt
Lieutenant Governor of Nevada

The Honorable Frankie Sue Del Papa
Attorney General of Nevada

Ms. Marybel Batjer
Chief of Staff
Office of the Governor

The Honorable William Raggio
Majority Leader
Nevada State Senate

The Honorable Dina Titus
Minority Leader
Nevada State Senate

The Honorable Richard Perkins
Speaker of the House
Nevada State Assembly

The Honorable Barbara Buckley
Majority Floor Leader
Nevada State Assembly

The Honorable Lynn Hettrick
Minority Floor Leader
Nevada State Assembly

The Honorable Lawrence E. Jacobsen
Chairman
Committee on High Level Radioactive Waste
Nevada State Legislature

The Honorable Marry Mortenson
Vice Chairman
Committee on High Level Radioactive Waste
Nevada State Legislature

Mr. John Meder
Research Division
Legislative Council Bureau
Nevada State Legislature

D.3.2 STATE AND LOCAL AGENCIES AND OFFICIALS

Mr. Alan Kalt
Comptroller
Churchill County

Ms. Irene Navis
Planning Manager
Clark County

Mr. George McCorkill
Program Director
Nuclear Waste Repository Oversight Program
Esmeralda County

Mr. Leonard Fiorenzi
Public Works Director
Eureka County

Mr. Andrew Remus
Yucca Mountain Repository Assessment Office
Inyo County

Mr. Mickey Yarbrow
Chair, Board of Commissioners
Lander County

Mr. Jason Pitts
Administrative Coordinator
Lincoln County

Ms. Judith A. Shankle
Administrator
Office of Nuclear Projects
Mineral County

Mr. Les Bradshaw
Manager
Department of Natural Resources and Federal
Facilities
Nye County

Mr. Dale Hammermeister
On-Site Representative
Department of Natural Resources and Federal
Facilities
Nye County

Ms. Josie Larson
Director
Nuclear Waste Project Office
White Pine County

Mr. Robert Ferraro
Mayor of Boulder City

Mr. Kevin Phillips
Mayor of Caliente

Mr. James Gibson
Mayor of Henderson

Mr. Oscar Goodman
Mayor of Las Vegas

Mr. Charles Horne
Mayor of Mesquite

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Mayor of North Las Vegas

Mr. Bob Cameron
Amargosa Valley Town Board Chair

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Chair
Beatty Town Advisory Board

Mr. Tim Leavitt
Pahrump Town Board Chair

Mr. Thomas Stephens
Director
Nevada Department of Transportation

Mr. Hugh Ricci
State Engineer
Nevada Division of Water Resources

Mr. Brian McKay
Chairman
Nevada Commission on Nuclear Projects

Mr. Robert Loux
Executive Director
Agency for Nuclear Projects
State of Nevada

Mr. Robert Halstead
Transportation Advisor
Agency for Nuclear Projects
State of Nevada

Mr. Joe Strolin
Administrator of Planning
Agency for Nuclear Projects
State of Nevada

D.4 Other States and Territories

The Honorable Don Siegelman
Governor of Alabama

The Honorable Frank O'Bannon
Governor of Indiana

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Governor of Alaska

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Governor of Iowa

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Governor of American Samoa

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Governor of Kansas

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Governor of Arizona

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Governor of Kentucky

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Governor of Arkansas

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Governor of Louisiana

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Governor of California

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Governor of Connecticut

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Governor of Massachusetts

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Governor of Delaware

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Governor of Michigan

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Governor of Florida

The Honorable Jesse Ventura
Governor of Minnesota

The Honorable Roy Barnes
Governor of Georgia

The Honorable Ronnie Musgrove
Governor of Mississippi

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Governor of Guam

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Governor of Missouri

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Governor of Hawaii

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Governor of Montana

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Governor of Idaho

The Honorable Mike Johanns
Governor of Nebraska

The Honorable George Ryan
Governor of Illinois

The Honorable Jeanne C. Shaheen
Governor of New Hampshire

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Acting Governor of New Jersey

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Governor of New Mexico

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Governor of Puerto Rico

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Governor of South Carolina

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Governor of South Dakota

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Governor of Tennessee

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Governor of Texas

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Governor of Utah

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Governor of Vermont

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Governor of Virginia

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Governor of Virgin Islands

The Honorable Gary Locke
Governor of Washington

The Honorable Bob Wise
Governor of West Virginia

The Honorable Scott McCallum
Governor of Wisconsin

The Honorable Jim Geringer
Governor of Wyoming

D.5 Native American Groups

Mr. Curtis Anderson
Tribal Chairperson
Las Vegas Paiute Colony

Ms. Geneal Anderson
Tribal Chairperson
Paiute Indian Tribes of Utah

Mr. Richard Arnold
Tribal Chairperson
Pahrump Paiute Tribe

Ms. Rose Marie Bahe
Tribal Chairperson
Benton Paiute Indian Tribe

Ms. Carmen Bradley
Tribal Chairperson
Kaibab Band of Southern Paiutes

Mr. James Birchim
Tribal Chairperson
Yomba Shoshone Tribe

Mr. David Chavez
Tribal Chairperson
Chemehuevi Indian Tribe

Mr. Daniel Eddy, Jr.
Tribal Chairperson
Colorado River Indian Tribes

Ms. Pauline Esteves
Tribal Chairperson
Timbisha Shoshone Tribe

Mr. Monty Bengochia
Tribal Chairperson
Bishop Paiute Indian Tribe

Mr. Jesse Leeds
Chairman of the Board
Las Vegas Indian Center

Mr. Frederick I. Marr
Counsel to the Timbisha Shoshone Tribe

Mr. Henry Blackeye, Jr.
Tribal Chairperson
Duckwater Shoshone Tribe

Ms. Patricia Vance
Tribal Chairperson
Big Pine Paiute Tribe of the Owens Valley

Mr. Vernon Miller
Tribal Chairperson
Fort Independence Indian Tribe

Mr. Alfred Stanton
Tribal Chairperson
Ely Shoshone Tribe

Mr. Eugene Tom
Tribal Chairperson
Moapa Paiute Indian Tribe

Ms. Racheal Joseph
Interim Tribal Chairperson
Lone Pine Paiute-Shoshone Tribe

Mr. Darryl Bahe
Tribal Representative
Benton Paiute Indian Tribe

Ms. Lila Carter
Tribal Representative
Las Vegas Paiute Colony

Mr. Jerry Charles
Tribal Representative
Ely Shoshone Tribe

Mr. Lee Chavez
Tribal Representative
Bishop Paiute Indian Tribe

Ms. Betty L. Cornelius
Tribal Representative
Colorado River Indian Tribes

Mr. Maurice Frank-Churchill
Tribal Representative
Yomba Shoshone Tribe

Ms. Grace Goad
Tribal Representative
Timbisha Shoshone Tribe

Ms. Vivienne-Caron Jake
Tribal Representative
Kaibab Band of Southern Paiutes

Mr. Mel Joseph
Tribal Representative
Lone Pine Paiute-Shoshone Tribe

Ms. Lawanda Laffoon
Tribal Representative
Colorado River Indian Tribes

Ms. Cynthia V. Lynch
Tribal Representative
Pahrump Paiute Tribe

Mr. Calvin Meyers
Tribal Representative
Moapa Paiute Indian Tribe

Ms. Clara Belle Jim
Tribal Representative
Pahrump Paiute Tribe

Ms. Marian Zucco
Tribal Representative
Big Pine Paiute Tribe of the Owens Valley

Ms. Lalovi Miller
Tribal Representative
Moapa Paiute Indian Tribe

Ms. Bertha Moose
Tribal Representative
Big Pine Paiute Tribe of the Owens Valley

Ms. Gaylene Moose
Tribal Representative
Bishop Paiute Tribe

Ms. Eleanor Hemphill
Tribal Representative
Fort Independence Indian Tribe

Ms. Vermina Stevens
Chairman
Elko Band Council

Ms. Lydia Sam
Chairman
Battle Mountain Band Council

Ms. Michelle Saulque
Tribal Representative
Benton Paiute Indian Tribe

Ms. Gevene E. Savala
Tribal Representative
Kaibab Band of Southern Paiutes

Ms. Stacy Stahl
Tribal Chairperson
Yerington Tribal Council

Mr. Darryl Crawford
Executive Director
Nevada Indian Environmental Coalition
Inter-Tribal Council of Nevada

Mr. Steve Poole
Nevada Indian Environmental Coalition
Inter-Tribal Council of Nevada

Mr. Darryl King
Tribal Representative
Chemehuevi Tribe

Mr. Willie Johnny
Vice-Chairperson
Wells Band Council

Ms. Ernestine Coble
Fort McDermitt Paiute-Shoshone Tribe
MRS Project Office

Ms. Helen Snapp
Fort McDermitt Paiute Shoshone Tribe

Mr. Brian Wallace
Chairman
Washoe Tribal Council

Mr. Alvin James
Pyramid Lake Paiute Tribe

Mr. William Rosse, Sr.
Western Shoshone Nation

D.6 Environmental and Public Interest Groups

D.6.1 NATIONAL

Mr. Jim Bridgman
Program Associate
Alliance for Nuclear Accountability
Washington, D.C.

Ms. Susan Gordon
Director
Alliance for Nuclear Accountability
Seattle, WA

Ms. Rebecca K. Blood
Senior Government Relations Representative
American Public Power Association
Washington, D.C.

Ms. Janet Greenwald
Citizens for Alternatives to Radioactive Dumping
(CARD)
Albuquerque, NM

Dr. Mildred McClain
Harambee House, Inc.
Citizens for Environmental Justice, Inc.
Savannah, GA

Mr. Jerry Pardilla
National Tribal Environmental Council
Albuquerque, NM

Ms. Suzanne Westerly
Acting Executive Director
Concerned Citizens for Nuclear Safety
Santa Fe, NM

Mr. Seth Kirshenberg
Executive Director
Energy Communities Alliance
Washington, D.C.

Mr. Fred Krupp
Executive Director
National Headquarters
Environmental Defense Fund, Inc.
New York, NY

Mr. Daniel Kirshner
Senior Economic Analyst
West Coast Office
Environmental Defense Fund, Inc.
Oakland, CA

Mr. Chuck Broschious
Executive Director
Environmental Defense Institute
Troy, ID

Dr. Gawain Kripke
Director, Economics Programs
Friends of the Earth
Washington, D.C.

Mr. Tom Carpenter
Government Accountability Project
West Coast Office
Seattle, WA

Mr. Steven Dolley
Research Director
Nuclear Control Institute
Washington, D.C.

Mr. Tom Goldtooth
National Coordinator
Indigenous Environmental Network
Bemidji, MN

Dr. Arjun Makhijani
President
Institute for Energy and Environmental
Research (IEER)
Takoma Park, MD

Mr. Daniel Taylor
Executive Director
California State Office
National Audubon Society
Sacramento, CA

Ms. JoAnn Chase
Executive Director
National Congress of American Indians
Washington, D.C.

Ms. Libby Fayad
Counsel
National Parks and Conservation Association
Washington, D.C.

Mr. Steven Shimberg, Vice President
Federal and International Affairs
National Wildlife Federation
Washington, D.C.

Ms. Gail Small
Native Action
Lame Deer, MT

Ms. Jill Kennay
Resources Manager
Natural Land Institute
Rockford, IL

Dr. Thomas B. Cochran
Director, Nuclear Programs
Natural Resources Defense Council, Inc.
Washington, D.C.

Mr. David Beckman
Los Angeles Office
Natural Resources Defense Council
Los Angeles, CA

Mr. Eric Goldstein
New York Office
Natural Resources Defense Council
New York, NY

Ms. Maggie Coon
Director of Government Relations
The Nature Conservancy
Arlington, VA

Mr. Graham Chisholm
State Director
Nevada Field Office
The Nature Conservancy
Reno, NV

Mr. Ralph Hutchison
Coordinator
Oak Ridge Environmental Peace Alliance
Oak Ridge, TN

Dr. Robert K. Musil, Ph.D.
Executive Director
Physicians for Social Responsibility
Washington, D.C.

Ms. Christine Chandler
Responsible Environmental Action League
Los Alamos, NM

Mr. Tom Marshall
Rocky Mountain Peace and Justice Center
Boulder, CO

Mr. Scott Denman
Executive Director
Safe Energy Communication Council
Washington, D.C.

Ms. Barbara Boyle
Regional Director
CA/NV/HI Office
Sierra Club
Sacramento, CA

Ms. Beatrice Brailsford
Program Director
Snake River Alliance
Pocatello, ID

Mr. Richard Moore
Southwest Network for Environmental and
Economic Justice
Albuquerque, NM

Mr. Don Hancock
Southwest Research and Information Center
Albuquerque, NM

Ms. Marylia Kelley
Tri-Valley CAREs
Livermore, CA

Mr. Alden Meyer
Director, Government Relations
Union of Concerned Scientists
Washington, D.C.

Mr. Kevin Kamps
Nuclear Waste Specialist
Nuclear Information and Resource Service
Washington, D.C.

Mr. Tom Zamora Collina
Director of Arms Control Project
Union of Concerned Scientists
Washington, D.C.

Ms. Jackie Cabasso
Executive Director
Western States Legal Foundation
Oakland, CA

Ms. Diane Jackson
Administrative Assistant
Ecology and Economics Research Department
The Wilderness Society
Washington, D.C.

Mr. Theodore Webb
Peace Action
Sacramento, CA

Ms. Shelby Jones
Solar Presents
Sacramento, CA

Ms. Lorraine Krofchok
Grandmothers for Peace
Sacramento, CA

Ms. Shiela Baker
Nuclear Waste Information Committee
San Luis Obispo, CA

D.6.2 STATE AND LOCAL

Ms. Kaitlin Backlund
Executive Director
Citizen Alert
Las Vegas, NV

Ms. M. Lee Dazey
Northern Nevada Director
Citizen Alert
Reno, NV

Ms. Allie Smith
Citizen Alert
Las Vegas, NV

Co-Chair, Northern Nevada
The Study Committee
Dayton, NV

Mr. Bill Vasconi
Co-Chair, Southern Nevada
The Study Committee
Las Vegas, NV

Ms. Judy Treichel
Nevada Nuclear Waste Task Force
Las Vegas, NV

Ms. Grace Potorti
Rural Alliance For Military Accountability
Reno, NV

D.7 Other Groups and Individuals

Ms. Janice Owens
Director
Nuclear Waste Programs
National Association of Regulatory Utility
Commissioners

Mr. Joe F. Colvin
President and Chief Executive Officer
Nuclear Energy Institute

Ms. Angelina S. Howard
Senior Vice President
Industry Communications Division
Nuclear Energy Institute

Mr. Marvin S. Fertel
Senior Vice President
Nuclear Infrastructure Support and International
Programs Division
Nuclear Energy Institute

Mr. Ralph E. Beedle
Senior Vice President
Nuclear Generation Division
Nuclear Energy Institute

Mr. John E. Kane
Vice President
Government Affairs Division
Nuclear Energy Institute

Mr. Steven P. Kraft
Director
Nuclear Fuel Management
Nuclear Energy Institute

Mr. Ralph Andersen
Project Manager
Plant Support
Nuclear Energy Institute

Mr. Ron McCullum
Senior Project Manager
Hughes Nuclear Fuel
Nuclear Energy Institute

Mr. Scott Peterson
Senior Director
External Communications
Nuclear Energy Institute

Mr. Steven Kerekes
Section Manager
Media Relations
Nuclear Energy Institute

Dr. Klaus Stezenbach
Director
Harry Reid Center for Environmental Studies
University of Nevada, Las Vegas

Dr. Don Baepler
Director of Museum
Harry Reid Center for Environmental Studies
University of Nevada, Las Vegas

Dr. Stephen Wells
President
Desert Research Institute

Mr. Rex Massey
RMA Research

Mr. Chris Binzer
Robison-Seidler

Ms. Ginger Swartz
Swartz and Associates

D.8 Reading Rooms and Libraries

Mr. Andrew Remus
Inyo County Yucca Mountain Repository
Assessment Office
Independence, CA

Ms. Laura Martinez
U.S. Department of Energy
Public Reading Room
Oakland, CA

Mr. John Horst
National Renewable Energy Laboratory
Public Reading Room
Golden, CO

Mr. Gary Morrell
Rocky Flats Public Reading Room
Westminster, CO

Ms. Nancy Mays/Ms. Laura Nicholas
Atlanta Support Office
U.S. Department of Energy
Public Reading Room
Atlanta, GA

Mr. Joel W. Seymour
Southeastern Power Administration
U.S. Department of Energy
Reading Room
Elberton, GA

Mr. Adrien Taylor
Boise State University Library
Government Documents
Boise, ID

Mr. Brent Jacobson
Idaho Operations Office
U.S. Department of Energy
Public Reading Room
Idaho Falls, ID

Mr. John Shuler
Chicago Operations Office
Document Department
University of Illinois at Chicago
Chicago, IL

Ms. Deanna Harvey
Strategic Petroleum Reserve Project
Management Office
U.S. Department of Energy
SPRPMO/SEB Reading Room
New Orleans, LA

Mr. Alan Kalt
Churchill County
Fallon, NV

Mr. Dennis Bechtel
Clark County
Las Vegas, NV

Ms. Aimee Quinn
Government Publications
Dickenson Library
University of Nevada, Las Vegas

Mr. George McCorkell
Esmeralda County
Repository Oversight Program
Goldfield, NV

Mr. Leonard Fiorenzi
Eureka County
Courthouse Annex
Eureka, NV

Mr. Mickey Yarbrow
Lander County
Austin, NV

Mr. Jason Pitts
Lincoln County
Caliente, NV 89008

Ms. Judy Shankle
Mineral County
Hawthorne, NV

Ms. Heather Elliot
Nevada State Clearinghouse
Department of Administration
Carson City, NV

Mr. Les Bradshaw
Nye County
Department of Natural Resources and
Federal Facilities
Pahrump, NV

University of Nevada, Reno
The University of Nevada Libraries
Business and Government Information Center
Reno, NV

Ms. Josie Larson
White Pine County
Ely, NV

Ms. Marina Anderson
Beatty Yucca Mountain Science Center
Beatty, NV

Mr. John Pawlak
Las Vegas Yucca Mountain Science Center
Las Vegas, NV

Ms. Terri Brown
Pahrump Yucca Mountain Science Center
Pahrump, NV

Ms. Dawn Knepper
Albuquerque Operations Office
U.S. Department of Energy
Contract Reading Room
Kirtland Air Force Base
Albuquerque, NM

Ms. Diane Rayer
Fernald Area Office
U.S. Department of Energy
Public Information Room
Cincinnati, OH

Ms. Marti Ayers
Southwestern Power Administration
U.S. Department of Energy
Tulsa, OK

Mr. Bill Zimmerman/Ms. Darlene Freestad
Bonneville Power Administration
U.S. Department of Energy
Portland, OR

Ms. Ann C. Dunlap
Pittsburgh Energy Technology Center
U.S. Department of Energy
Pittsburgh, PA

Ms. Pauline Connell
Savannah River Operations Office
Gregg-Graniteville Library
University of South Carolina-Aiken
Aiken, SC

Mr. William Suddeth
University of South Carolina
Thomas Cooper Library
Documents/Microforms Department
Columbia, SC

Mr. Walter Perry
Oak Ridge Operations Office
U.S. Department of Energy
Public Reading Room
American Museum of Science and Energy
Oak Ridge, TN

Mr. Stephen Short
Southern Methodist University
Central Union Libraries Fondren Library
Government Information
Dallas, TX

Mr. Walter Jones
University of Utah
Marriott Library
Special Collections
Salt Lake City, UT

Ms. Carolyn Lawson
Headquarters Office
U.S. Department of Energy
Washington, D.C.

Ms. Terri Traub
Richland Operations Center
U.S. Department of Energy
Public Reading Room
Richland, WA



Appendix E

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Z

CONVERSIONS

METRIC TO ENGLISH			ENGLISH TO METRIC		
Multiply	by	To get	Multiply	by	To get
Area					
Square meters	10.764	Square feet	Square feet	0.092903	Square meters
Square kilometers	247.1	Acres	Acres	0.0040469	Square kilometers
Square kilometers	0.3861	Square miles	Square miles	2.59	Square kilometers
Concentration					
Kilograms/sq. meter	0.16667	Tons/acre	Tons/acre	0.5999	Kilograms/sq. meter
Milligrams/liter ^a	1	Parts/million	Parts/million ^a	1	Milligrams/liter
Micrograms/liter ^a	1	Parts/billion	Parts/billion ^a	1	Micrograms/liter
Micrograms/cu. meter ^a	1	Parts/trillion	Parts/trillion ^a	1	Micrograms/cu. meter
Density					
Grams/cu. cm	62.428	Pounds/cu. ft.	Pounds/cu. ft.	0.016018	Grams/cu. cm
Grams/cu. meter	0.0000624	Pounds/cu. ft.	Pounds/cu. ft.	16,025.6	Grams/cu. meter
Length					
Centimeters	0.3937	Inches	Inches	2.54	Centimeters
Meters	3.2808	Feet	Feet	0.3048	Meters
Kilometers	0.62137	Miles	Miles	1.6093	Kilometers
Temperature					
<i>Absolute</i>					
Degrees C + 17.78	1.8	Degrees F	Degrees F – 32	0.55556	Degrees C
<i>Relative</i>					
Degrees C	1.8	Degrees F	Degrees F	0.55556	Degrees C
Velocity/Rate					
Cu. meters/second	2118.9	Cu. feet/minute	Cu. feet/minute	0.00047195	Cu. meters/second
Grams/second	7.9366	Pounds/hour	Pounds/hour	0.126	Grams/second
Meters/second	2.237	Miles/hour	Miles/hour	0.44704	Meters/second
Volume					
Liters	0.26418	Gallons	Gallons	3.78533	Liters
Liters	0.035316	Cubic feet	Cubic feet	28.316	Liters
Liters	0.001308	Cubic yards	Cubic yards	764.54	Liters
Cubic meters	264.17	Gallons	Gallons	0.0037854	Cubic meters
Cubic meters	35.314	Cubic feet	Cubic feet	0.028317	Cubic meters
Cubic meters	1.3079	Cubic yards	Cubic yards	0.76456	Cubic meters
Cubic meters	0.0008107	Acre-feet	Acre-feet	1233.49	Cubic meters
Weight/Mass					
Grams	0.035274	Ounces	Ounces	28.35	Grams
Kilograms	2.2046	Pounds	Pounds	0.45359	Kilograms
Kilograms	0.0011023	Tons (short)	Tons (short)	907.18	Kilograms
Metric tons	1.1023	Tons (short)	Tons (short)	0.90718	Metric tons
ENGLISH TO ENGLISH					
Acre-feet	325,850.7	Gallons	Gallons	0.000003046	Acre-feet
Acres	43,560	Square feet	Square feet	0.000022957	Acres
Square miles	640	Acres	Acres	0.0015625	Square miles

a. These widely used conversions are only valid under specific temperature and pressure conditions.

METRIC PREFIXES

Prefix	Symbol	Multiplication factor
exa-	E	1,000,000,000,000,000,000 = 10 ¹⁸
peta-	P	1,000,000,000,000,000 = 10 ¹⁵
tera-	T	1,000,000,000,000 = 10 ¹²
giga-	G	1,000,000,000 = 10 ⁹
mega-	M	1,000,000 = 10 ⁶
kilo-	k	1,000 = 10 ³
deca-	D	10 = 10 ¹
deci-	d	0.1 = 10 ⁻¹
centi-	c	0.01 = 10 ⁻²
milli-	m	0.001 = 10 ⁻³
micro-	μ	0.000 001 = 10 ⁻⁶
nano-	n	0.000 000 001 = 10 ⁻⁹
pico-	p	0.000 000 000 001 = 10 ⁻¹²